Chapter 33
A FRT – SVD Based Blind Medical Watermarking Technique for Telemedicine Applications

Surekah Borra
K. S. Institute of Technology, Bengaluru, India

Rohit Thanki
https://orcid.org/0000-0002-0645-6266
C. U. Shah University, Wadhwan, India

ABSTRACT

In this article, a blind and robust medical image watermarking technique based on Finite Ridgelet Transform (FRT) and Singular Value Decomposition (SVD) is proposed. A host medical image is first transformed into 16 × 16 non-overlapping blocks and then ridgelet transform is applied on the individual blocks to obtain sets of ridgelet coefficients. SVD is then applied on these sets, to obtain the corresponding U, S and V matrix. The watermark information is embedded into the host medical image by modification of the value of the significant elements of U matrix. This proposed technique is tested on various types of medical images such as X-ray and CT scan. The simulation results revealed that this technique provides better imperceptibility, with an average PSNR being 42.95 dB for all test medical images. This technique also overcomes the limitation of the existing technique which is applicable on only the Region of Interest (ROI) of the medical image.

1. INTRODUCTION

In the last few years, medical treatments and diagnosis of the patients are being solved with the support of a variety of medical data such as images or signals. While the examples of medical images which are widely used are Magnetic Resonance Imaging (MRI), X-ray, Computerized Tomography (CT) and

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Ultrasound (US), the examples of 1-D medical signals are ECG and EEG signals. Nowadays, it has become a common practice to share medical data among doctors and radiologists for better diagnosis, health solution, and treatment. Transferring medical images over a transmission medium is referred to as telemedicine (American Hospital Association, 2015; Yassin, 2015). The telemedicine aids in emergency treatment, home monitoring, military applications and medical education (Yassin, 2015) to name a few. Security of medical images becomes necessary when they are transferred over any open access network. Corruption or modification of medical images by someone or some process leads to serious health issues for any individual. There is in fact high probability for the medical images being corrupted or modified by various intentional and unintentional processing during storage or transmission over a medium. While various techniques such as cryptography and steganography are available for protecting medical images, the digital watermarking technique is the proven solution for copyright protection (Borra et al., 2017; Thanki et al., 2017; Lakshmi and Borra, 2016; Borra and Lakshmi, 2015; Borra and Swamy, 2014; Borra et al., 2012; Borra and Swamy, 2012; Thanki et al., 2011; Borra and Swamy, 2009).

1.1. Related Work

In the last few years, various watermarking techniques based on Singular Value Decomposition (SVD) and its combinations with other transforms have been proposed for security of medical image. F. Thakkar (Thakkar and Srivastava, 2017) has used SVD-DWT transform coefficients for embedding watermark information into the U matrix of SVD. In this technique, first column second row value and first column third row value of U block of LL subband of the host medical image is modified according to watermark bits. This technique is modified version of Su technique (Su et al., 2013), wherein the same U block is used for watermark bit embedding. A major limitation of the Thakkar technique is that it is only applicable on Region of Interest (ROI) of medical images or high contrast medical images. Also, extraction of watermark data resulted in poor quality, less imperceptibility, and poor robustness. A. Singh (Singh et al., 2014) has proposed two watermarking techniques based on the combinations of DWT, SVD, and cryptography for the security of medical images. In this technique, authors used three different error correcting codes: Hamming, Bose-Chaudhuri-Hocquenghem (BCH) and Reed-Solomon code for encoding watermark data. Later, this encoded watermark data is embedded into wavelet coefficients of the medical image in wavelet-based technique, and singular values of the medical image in SVD based technique, respectively. Authors suggested that Reed-Solomon based encoded watermark data performed better than other two error correcting codes. N. Venkatram (Venkatram et al., 2014) has proposed 2D Lifting Wavelet Transform (LWT) and SVD based medical image watermarking technique. N. Dey (Dey et al., 2012a, 2012b; proposed a hybrid medical image watermarking technique using three image processing transforms such as DCT, DWT, and SVD. A. Singh (Singh, 2015) proposed hybrid watermarking techniques for medical image protection. These techniques are designed by combining DWT, SVD and spread spectrum approach.

After a detailed survey of SVD based medical image watermarking techniques, it is observed that most of the existing watermarking techniques are less imperceptible and less robust. This paper aims at overcoming the limitations of existing techniques, in particular, Thakkar technique (Thakkar and Srivastava, 2017) where it is only applicable on Region of Interest (ROI) of medical images, or for high contrast medical images. Thus, a new hybrid watermarking technique is designed and proposed using a combination of Finite Ridgelet Transform (FRT) and SVD is this paper. The other motivation for proposing this technique is that a very less number of techniques are designed and implemented using